DOCUMENT RESUME

ED 243 940 TM 840 253

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TITLE The Effects of Intelligence, Self-Concept, and Attributional Style on Metamemory and Memory Behavior: A Developmental Study. Paper 1.
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PUB DATE Apr 84
NOTE 37p.; Paper presented at the Annual Meeting of the American Educational Research Association (68th, New Orleans, LA, April 23-27, 1984).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Attribution Theory; Cognitive Development; Correlation; Elementary Education; Grade 3; Grade 5; Grade 7; *Intelligence; Intelligence Tests; Interviews; *Memory; *Metacognition; Recall (Psychology); *Self Concept Measures
IDENTIFIERS Cattell Culture Fair Intelligence Test; Cognitive Abilities Test

ABSTRACT

The influence of intelligence, self-concept, and causal attributions on metamemory and the metamemory-memory behavior relationship in grade-school children was studied. Following the assessment of intelligence, self-concept, and causal attributions, 105 children each from grades 3, 5, and 7 were given a metamemory interview and a sort-recall task. Metamemory, strategy, and recall scores increased with age. The correlation between general metamemory, strategy use, and memory performance with intelligence, self-concept, and causal attributions partialled out was significant, irrespective of age. Additional analyses using a causal modeling approach (LISREL) showed that intelligence and (to a lesser degree) self-concept and attributional style had an impact on metamemory in all age groups, but that metamemory did have a significant direct effect on memory behavior and/or memory performance. The study therefore provides support for the assumption that metamemory remains an important predictor of memory behavior and performance even after the influence of conceptually related constructs have been taken into account. (Author)

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The Effects of Intelligence, Self-Concept, and Attributional Style on Metamemory and Memory Behavior: A Developmental Study

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TM 840 253

Paper presented at the annual meeting of the American Educational Research Association, New Orleans, 1984

Paper 1/1984

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Abstract

The influence of intelligence, self-concept, and causal attributions on metamemory and the metamemory-memory behavior relationship in grade-school children was studied. Following the assessment of intelligence, self-concept, and causal attributions, 105 children each from grades 3, 5, and 7 were given a metamemory interview and a sort-recall task. Metamemory, strategy, and recall scores increased with age. The correlation between general metamemory, strategy use, and memory performance with intelligence, self-concept, and causal attributions partialled out was significant, irrespective of age. Additional analyses using a causal modeling approach (LISREL) showed that intelligence and (to a lesser degree) self-concept and attributional style had an impact on metamemory in all age groups, but that metamemory did have a significant direct effect on memory behavior and/or memory performance. The study therefore provides support for the assumption that metamemory remains an important predictor of memory behavior and performance even after the influence of conceptually related constructs have been taken into account.

The Effects of Intelligence, Self-Concept, and Attributional Style on Metamemory and Memory Behavior: A Developmental Study

Research on the development of children's metamemory, that is, their introspective knowledge about their own memory funtioning and the memory system (Flavell & Wellman, 1977), has been stimulated by the assumption that metamemory could serve as a possible explanation for strategy development during the elementary school years. Although it has been repeatedly pointed out that a stable and high correlation between metamemory and memory behavior is not always to be expected (cf. Flavell, 1978; Weinert, 1984), one of the most frequent arguments in favor of studying metamemory was that in general there should be a close relationship between metamemory and performance in various memory tasks.

By and large, however, earlier attempts to demonstrate causal linkages between metamemory and memory behavior were rather unsuccessful, particularly when organizational strategies in sort-recall tasks were investigated (cf. the review given by Cavanaugh & Perlmutter, 1982). From a theoretical viewpoint, the unexpected results could be due to two reasons. First, the context of free recall learning involving the use of subjects' preexisting organizational strategies may be less favorable for younger children. Here, metamemory and memory might be closely related in contexts where maintenance and transfer on newly learned and instructed strategies are tested. It was argued that this context requires a decision about whether to use or to abandon a previously learned strategy (cf. Borkowski, Reid, & Kurtz, in press; Cananaugh & Borkowski, 1980).

In fact, a meta-analysis of the literature (Schneider, in press) revealed that much stronger links between metamemory and

usage of organizational strategies were found in those studies that included strategy training and a transfer paradigm.

Second, there is reason to assume that poor assessment of metamemory in the earlier studies contributed to the disappointing results (Kurtz, Reid, Borkowski, & Cavanaugh, 1982). More recent investigations into the metamemory-memory behavior relationship including both strategy training and more reliable metamemory assessment procedures (e.g., Borkowski, Peck, Reid & Kurtz, 1983; Kurtz & Borkowski, in press) could demonstrate the important role of metamemory in strategy acquisition, maintenance, and generalization in sort-recall tasks.

Undoubtedly, improving reliability of metamemory assessment techniques is necessary but not sufficient with regard to establishing and proving construct validity. From a theoretical viewpoint, the concept of metamemory is closely related to constructs like intelligence, self-concept, causal attributions, and cognitive style (see Borkowski, in press; Flavell, 1984). Given this conceptual overlap, the theoretical value of the metamemory construct depends on the question if it still predicts memory behavior and performance when its interrelationship with related cognitive and affective student characteristics has been taken into account. In a few recent studies, an attempt was made to test this hypothesis.

As to the impact of intelligence, Borkowski et al. (1983) and Kurtz et al. (1982) found that the metamemory-strategy use correlation remained significant when performance on the intelligence test was partialled out, and that IQ failed to predict strategy use in the transfer tasks. Similarly, Borkowski et al.

(1983) reported that the correlation between metamemory and strategy with impulsivity partialled out remained significant, and that the cognitive tempo-strategy use correlation was not significant when metamemory was removed. It should be noted that significant correlations between metamemory, IQ and impulsivity were found.

The importance of causal attributions was demonstrated by Fabricius & Hagen (in press) and Lodico, Ghatala, Levin, Pressley, and Bell (1983) using causal attributions as indicators of strategy knowledge. In either study, causal attributions predicted use of the more effective strategy on a later trial. When analyzing the effects of causal attributions on metamemory and strategy use, Kurtz and Borkowski (in press) found that those children who attributed success to controllable factors like effort were both more strategic and higher in metamemory than those who attributed task outcomes to non-controllable factors like ability and task difficulty. However, no comparisons of the relative impact of causal attributions and metamemory on strategy use were reported in these studies.

Taken together, all these studies confirm the assumption that metamemory, intelligence, causal attributions, and cognitive style are interrelated to some extent, but at the same time provide evidence for the fact that metamemory remains an important predictor of memory behavior even when the impact of related constructs has been partialled out.

In the present study, an attempt was made to provide a more conservative test of metamemory's independent impact on memory behavior and performance. As a consequence, the study differed

from those described above with regard to three aspects. First, the context of free recall learning was chosen instead of maintenance and transfer tests. As Fabricius and Hagen (in press) pointed out, a stronger argument for the robustness and generality of the role of strategy knowledge in the development of memory would be made if different methodologies lead to converging evidence. Although the context of free recall learning did not prove favorable for the emergence of close metamemory-memory connections in earlier studies, it was assumed that a more reliable assessment of metamemory should be sufficient to get stable metamemory-memory behavior relationships.

Second, the influence of different related concepts on the metamemory-memory behavior relationship was assessed in this study by simultaneously considering the role of verbal intelligence, self concept, and causal attributions. Using these three constructs as covariates in a covariance analysis approach should provide a stronger test of the hypothesis that metamemory does have an independent impact on memory behavior and performance.

Third, a latent variable causal modeling approach (LISREL) was chosen to test this hypothesis more adequately. Recent studies in the topic (cf. Fabricius & Hagen, in press; Paris, Newman & McVey, 1982) used causal modeling (path analysis) with manifest variables to describe and explain the role of metamemory in the prediction of strategic behavior and recall. The approach chosen in the present study differs from these in that measurement error in observed variables is taken in to account and that the structural (causal) relationships are analyzed on the construct level and not on the level of manifest variables.

In a first session, third, fifth, and seventh graders were presented with several intelligence tests and questionnaires assessing self-concept and causal attributions. Next, a meta-memory interview was given, followed by a sort-recall task. In order to assess children's category sorting strategy they were asked to do anything with the stimuli that would help to remember them better. After the sorting and study period, subjects first had to predict the number of items that could be correctly recalled (i.e., memory monitoring as a second indicator of meta-memory), and then to recall as many items as possible. Subjects' ability to predict their recall for a future, highly similar sort-recall task was tested immediately after recall. Memory behavior (i.e., sorting during study and clustering during recall) was assessed by calculating the adjusted ratio of clustering (ARC scores developed by Roenker, Thompson, & Brown, 1971).

Method

Subjects

Subjects were 105 children each from grades 3, 5, and 7 drawn from several elementary and high schools located in middle-class neighborhoods in the area of Heidelberg, West Germany. There were approximately equal numbers of boys and girls in each grade. Mean ages were 9 years 2 months, 11 years 4 months, and 13 years 3 months for the third, fifth, and seventh grade children respectively. Testing was done at the middle of the school year.

Materials

Two intelligence subtests assessing verbal intelligence

were selected from the Cognitive Abilities Test (Heller, Gaedicke, & Weinläder, 1976). The verbal comprehension subtest required that subjects select a word out of five possible choices that corresponded most closely to an underlined keyword. In the word classification test, children were given three or four keywords that belonged in the same category and were asked to choose the one word that would fit best into the same category as the keywords.

In addition, the Matrices subtest of the Culture Fair Intelligence Test (Cattell & Weiss, 1978) assessing non-verbal intelligence was given. For each of the twelve items children were instructed to identify which of five possible answers completed a geometric pattern.

In order to assess subjects' attributional style, a self-constructed questionnaire consisting of 16 items was presented. Eight items referred to success situations, and the other eight items described failure situations. Half of the success items related to memory situations while the other half depicted everyday life situations. The same was true for the failure items. One point was given for each internal (i.e., high ability or high effort) attribution concerning a success situation, and for every variable attribution (i.e., bad luck or low effort) relating to a failure situation. A sum score collapsed across situations was computed that, according to more recent achievement motivation approaches (cf. Heckhausen, 1982), should reflect subjects' tendency towards success orientation.

Two self-concept scales were given that assessed children's perceived competence using different methodological approaches.

Using a more traditional vein, a 20-item self-concept questionnaire assessed subjects' perceived competence in school and memory-related contexts. Subjects had to judge if the statements given in the 20 items were true for them or not true for them. One point was given for each answer indicating a positive self-concept. - Next, a second self-concept task was given in which the children ranked themselves in terms of their abilities in relation to the rest of the class, ranging from "best in the class" to "worst in the class". Academic (e.g., reading, spelling, memory for texts) and non-academic (e.g., height, sports) items were included. For each item, a child's face on a bar graph was circled to represent relative position in the group. Scores ranged from 1 to 30, with a high score representing a positive self-concept. - The metamemory battery included 11 items, nine of which were similar to those originally developed by Kreutzer, Leonard, & Flavell(1975). Examples for these more general metamemory items included knowledge about text processing, and about the difference between gist recall and word-by-word recall of stories (rote-paraphrase).
The more task-specific component of metamemory consisted of one complex item that assessed subject's strategy preferences in different sort-recall tasks. A sum score was derived for both the general and the task-specific component of metamemory.

In the Sort Recall for Words (Words) task, each child was given a magnetic board and a set of 24 words that were mounted on 1 x 4 cm magnetized cardboards. The words were classified according to categories (e.g., names, fruits, vehicles) with six items in each category.

Procedure

Subjects received the intelligence tests first, followed by the attributional style questionnaire and the two self-concept scales. Next, children were given the metamemory questionnaire. All items were read aloud to the children as they scanned the booklet.

In the Word task, each child was given a metal magnetic board and instructed to arrange the words on the board so as to study them. They were told that two minutes would be given for study and that they should recall as many items as possible. After two minutes of study, the metal boards were collected, and recall sheets distributed. Subjects were first asked to predict how many words out of 24 they would be able to remember correctly; then they were given three minutes for recall. After recall, a short questionnaire was given assessing children's strategies while sorting and studying the items. Next, a second estimate was made of the number of words each child might remember if given a similar, new set of 24 words to study, using the same procedure and length of study time. The metal boards were individually photographed in order to serve as a record of sorting behavior. Thus cluster indices (ARC scores) could be obtained for both sorting during study and clustering during recall. The number of correctly recalled items served as an index of the subject's memory performance.

Results

IQ, Self-Concept, and Attributional Style

One-factor analyses of variance using grade as independent

and IQ, self-concept, and attributional style as dependent measures revealed significant age effects for the three intelligence subtests Word Comprehension (F (2, 312) = 3.07, $p < .05$), Classification (F (2, 312) = 5.74, $p < .01$), and Matrices (F (2, 312) = 37.16, $p < .01$). Post-hoc comparisons using Duncan's multiple range test showed that fifth and seventh-graders differed significantly from third-graders in the Word Comprehension and Classification tasks. No significant differences between fifth and seventh-graders were detected concerning these two intelligence subtests. On the other hand, significant differences among all three age groups were observed for the Matrices subtest. Here, seventh-graders were significantly better than fifth-graders, and fifth-graders significantly outperformed third-graders.

Similarly, overall age effects were found for the attributional scale (F (2, 312) = 5.50, $p < .01$) and for the nonverbal self-concept scale (F (2, 312) = 3.07, $p < .05$). Again, post-hoc comparisons revealed that fifth and seventh-graders significantly differed from third-graders in that they showed a more realistic (lower) self-concept and more success-orientation in the attributional scale, but that the two older age groups did not differ from each other. No significant age differences were found for the self-concept questionnaire (F (2, 312) = 0.83, p .05).

Metamemory, Memory Behavior, and Memory Performance

Consistent with the literature, significant age effects were observed for all memory-related measures included in the analysis. The three age groups significantly differed from each other with regard to task-specific metamemory (F (2, 312) = 11.29, $p < .01$), general metamemory (F (2, 312) = 80.11, $p < .01$), sorting behavior

(F (2, 312) = 25.36, $p < .01$), recall clustering (F (2, 312) = 24.30, $p < .01$), and recall (F (2, 312) = 101.70, $p < .01$). Furthermore, older subjects more frequently reported adequate strategy use (F (2, 312) = 44.26, $p < .01$) and estimated higher recall outcomes than younger children (F (2, 312) = 21.71, $p < .01$). Table 1 presents the means and standard deviations for all memory-related measures separately for each grade.

Insert Table 1 about here

Inpact of IQ, Self-Concept, and Causal Attributions on the Metamemory - Memory Behavior Relationship

Correlational analysis using manifest variables. Simple and partial correlations were calculated for metamemory, strategy use, and recall scores. Data were collapsed across grades in order to increase the degrees of freedom. As can be seen from Table 2, general metamemory showed higher correlations with the strategy use and recall measures, compared with task-specific metamemory. This unexpected finding seems to be due to the more reliable assessment of general metamemory. Although most of the correlation coefficients were statistically significant, only a few (e.g. the correlation between general metamemory and recall, strategy use and recall) also appeared to be practically important. Interestingly, simultaneously controlling for the influence of IQ, self-concept, and attributional style did not dramatically reduce the intercorrelations depicted in Table 2: most of them remained statistically significant with the IQ, self-concept, and attribution

variables partialled out.

Insert Table 2 about here

The relative effects of IQ, self-concept, and attributional style on task-specific metamemory were examined in three stepwise regression analyses (separately for each grade). Taken together, the three IQ subtests, the two self-concept scales and the attributional questionnaire only explained about 9 percent (third-graders), 10 percent (fifth-graders), and 3 percent (seventh-graders) in the variance of task-specific metamemory. When general metamemory was chosen as dependent variable, IQ, self-concept, and causal attributions did not explain more than 10, 13, and 17 percent of its variance for third, fifth, and seventh-graders, respectively. This finding indicates that the empirical overlap among the variables is surprisingly low.

Causal modeling using latent variables. The computer programm LISREL IV (Jöreskog & Sörbom, 1978) was chosen to analyse the influence of IQ, self-concept, and causal attributions on the metamemory - memory behavior connection using the level of latent variables. LISREL consists of two parts: while the measurement model defines the relationship between observed variables and unmeasured hypothetical constructs, the structural equation model (i.e., 'causal' model) is used to specify the causal links among the latent variables. Maximum likelihood estimates of measurement and causal parameters are obtained simultaneously; LISREL makes use of all information in the data about each parameter in generating its estimates. The efficiency of a given model is evaluated by a chi-square goodness-of-fit statistic which is a

direct function of the discrepancy between the sample correlation matrix and that reproduced by the parameter estimates of the model. A large chi-square (relative to the degrees of freedom) indicates that the model does not provide a plausible representation of the causal process.

The complete causal model chosen in the present study specifies that IQ and self-concept/attributional style serve as exogeneous constructs. This means that they are not further explained in the model. It is assumed that the exogeneous variables influence subjects' verbalizable knowledge about memory, which in turn should affect memory monitoring processes. Further, both components of metamemory (i.e., verbalizable knowledge and monitoring) are thought to directly influence strategic behavior in the sort-recall task. Finally, metamemory as well as strategic behavior should directly affect performance in the memory task.

The measurement model was constructed as follows: to avoid multicollinearity problems, the intelligence construct was represented by only two of the three IQ subtests described above. The two self-concept scales and the attributional style questionnaire were taken to build up the self-concept/attribution construct. Metamemory was comprised of the two components described above (i.e., task-specific and general metamemory), and the latent Memory Monitoring variable consisted of the two recall estimation measures mentioned above. A third recall estimate indicator assessed about ten months later in a sort-recall task using the same item list was added to provide a more stable representation of this construct. The Memory Behavior construct consisted of the two clustering indices for sorting and recall plus children's strategy

reports. The representation of the construct Memory Performance caused some problems because only one indicator (i.e., one recall measure) was available in the present study. Therefore, children's recall in the same sort-recall task given about ten months later was chosen as a second performance indicator. An average correlation of $\underline{r}$ = .65 between the two recall measures was regarded sufficient to justify the inclusion of the second recall score in the measurement model.

The first problem to be analyzed concerned the stability of factor structure in all three age groups. It was assumed that a measurement model would be reliable if it constrained both factor loadings and factor intercorrelations to have the same pattern across the three groups. But the result of a simultaneous confirmatory factor analysis (COFAMM) indicated that the proposed model did not fit the data (χ^2 = 762.46 with 357 degrees of freedom, $\underline{p} < .01$) As a consequence, independent solutions were developed for each group. There seemed to be no evidence that the same measurement model could hold for the three samples.

Tables 3 to 5 show the measurement models for the best-fitting LISREL solutions obtained for each age group.

Insert Tables 3 to 5 about here

A closer look at these tables reveals the main reason for the fact that one same model did not hold for all groups: it was only for the third graders that a pure simple structure could be found.

That is, only for this age group the constraint that every observed variable should load on only one factor proved to be in accord with the data. For all other age groups, the models had to be relaxed somewhat by introducing more parameters. In addition, it can be seen that some constructs are represented differentially in different age groups. With regard to IQ, for example, the model estimated for the seventh graders differs from those of the two younger age groups in that the construct is made up by the two verbal intelligence subtests instead of the combination of a verbal and a non-verbal subtest. Similarly, the self-concept/attributional style construct is dominated by self-concept indicators in grades 3 and 5 but not in grade 7, where the focus is on the attributional style component.

The next step of analysis concentrated on the estimation and testing of the full causal model. For each group, the measurement model resulting from the COFAMM analyses was combined with the structural ('causal') component in order to identify the most parsimoneous solution. The results for third, fifth and seventh-graders are depicted in Figures 1 to 3, respectively.

Insert Figures 1 to 3 about here

Here, only the causal links (i.e., structural coefficients) among the six latent variables are included in order to guarantee greater clearness. It should be pointed out that all models fit the data (χ^2 = 86.15 with 82 degrees of freedom, p = .36 for third-graders; χ^2 = 80.53 with 76 degrees of freedom, p = .34 for fifth-graders,

and $\chi^2 = 90.65$ with 82 degrees of freedom, $p = .24$ for the seventh-graders).

With regard to the central hypothesis of the present study, similar results were obtained for all age groups: although a moderate impact of IQ and an (even less important) influence of self-concept on metamemory could be demonstrated for most solutions, metamemory turned out to have a substantial effect on either memory behavior or memory performance, irrespective of grade. On the other hand, considerable differences were found concerning the specific relationship among metamemory, memory monitoring, memory behavior, and memory performance. Only for third-graders strong relations among metamemory, memory behavior, and memory performance were detected. Here, no substantial connection between verbalizable metamemory and recall prediction (i.e., memory monitoring) was found. Interestingly, metamemory strongly affected memory monitoring in both older age groups but had a considerably lower direct impact on memory behavior (moderate in fifth graders, non-existent in seventh-graders) and memory performance, where only for seventh-graders a substantial direct effect could be secured. In all age groups, subjects' recall estimates did not directly relate to memory behavior but significantly affected recall. It should be noted that all models did explain a high proportion of the variance in the criterion variable (i.e., memory performance), namely 84%, 92,1%, and 94,5% for third, fifth, and seventh-graders, respectively).

Discussion

By and large, the results of the present study corroborate the findings by Borkowski et al. (1983), Kurtz and Borkowski (in press),

and Kurtz et al. (1982) in that metamemory turned out to have a significant impact on memory behavior and performance even after the effects of IQ, self-concept, and causal attributions had been partialled out. This finding seems the more impressive as the IQ, self-concept, and attribution measures used in the present study were simultaneously included as covariates in order to provide a stronger test of the hypothesis that metamemory does have an independent influence on memory behavior and performance.

The fact that metamemory proved effective when the context of a free recall learning approach was used instead of the strategy training paradigm preferred in most other recent studies can be viewed as an argument for the robustness of the role of strategy knowledge in the development of memory. In our view, the different results obtained for task-specific and general metamemory in the present study provide support for the assumption that earlier studies using the free recall learning approach to assess the metamemory - memory behavior connection failed mainly because of unreliable, poor metamemory assessment. In the present study, task-specific metamemory was only represented by a few items, and the pattern of results resembles those obtained by the earlier, unsuccessful studies (cf. Table 2). That is, correlations among task-specific metamemory and memory behavior proved to be insignificant. A different pattern of results, however, was found for the relationship between general metamemory, memory behavior and performance. As mentioned above, the general metamemory component consisted of nine items that -- at least in part -- had already been proven useful in other studies (e.g., Borkowski et al.,1982, 1983). As a consequence, more substantial correlations were

obtained for the general metamemory - memory behavior and performance relationship. Thus the present study indicates that the free recall learning paradigm can be used to demonstrate significant metamemory - memory behavior relationships in advanced elementary school children. However, as this approach relies on cross-sectional data, nothing can be said about the durability and generalizability of the metamemory - memory behavior link. In this regard, strategy training approaches (i.e., short-term longitudinal studies) providing explicit metamemorial information appear much more promising (cf. Pressley, Borkowski, & O'Sullivan, in press).

As to the developmental trends of the metamemory - memory behavior relationship, the results of the causal modeling procedure using latent variables led to new insights. First of all, the test of an identical measurement model for all age groups revealed that different representations of the latent constructs had to be assumed for the three samples. In particular, the IQ and Self-concept/Attribution construct was built up differently for third, fifth, and seventh-graders. For example, the Self-concept/Attribution construct was dominated by the self-concept indicators in third and fifth-graders but by the attribution variable in seventh-graders. The inspection of measurement error estimates gives a possible explanation for this finding: measurement error for the attribution variable is extremely high (0.8) in third-graders and almost negligible in seventh-graders (.09). That is, the subordinate role of causal attributions in the composition of third-graders' Self-concept/Attribution construct seems to be due to unreliable assessment techniques. From this finding, there is reason to assume that stable attributions do not exist in this age group.

As can be seen from Figures 1 to 3, the LISREL solutions did not only differ with regard to measurement model properties but also concerning the causal models found to be in accord with the data for the three age groups. With regard to the central hypothesis of the present study, the most important finding was that IQ and -- to a lesser degree -- the Self-concept/Attribution construct directly influenced (task-specific and general) metamemory, but that metamemory itself did have a substantial direct impact on memory behavior and performance, particularly in third and fifth grades. The solution found for the seventh-graders differs from the two others in that metamemory did not affect memory behavior, and that memory behavior did not substantially influence memory performance. This finding may be due to ceiling effects for the sorting and recall clustering indices in this age group.

The Memory Monitoring construct was included in the model to learn more about its validity in the different age groups. From a theoretical point of view, estimations of one's own recall can be influenced by one's standard of excellence, level of aspiration, and other motivational variables that may even replace memory monitoring processes. Thus it was inferred that memory monitoring processes could be only assumed in the case of significant relationships between metamemory and recall estimates. As can be seen from Figure 1, the nearly non-existent link between Metamemory and Memory Monitoring indicates that we chose an inadequate construct label for the recall estimates of third-graders. On the other hand, there is reason to assume that the Memory Monitoring construct does reflect metacognitive processes for the fifth and seventh-graders (cf. Figures 2 and 3).

As to the differentiation between motivational and cognitive processes, a similar problem exists for the Self-concept/Attribution construct. So Weinert (1984) pointed out that indicators of self-concept and causal attribution have been equally used in studies on metacognition and studies on motivational processes, but that they do have different functions in motivational and metacognitive models. Given the low empirical relationship between the Self-concept/Attribution construct and the other latent variables, it is open to question if the construct has a more motivational or more cognitive flavor.

All in all, the results of the latent variable causal analyses appear to confirm the findings by Borkowski et al. (1983) based on manifest variables: Metamemory maintained its direct influence on memory behavior in children even after its relationship with conceptually related constructs had been taken into account. Interestingly, the causal models developed for each age group fit the data nearly equally well. It should be emphasized that the structural pattern of results was not directly comparable across the age groups. To test the hypothesis that the age-specific patterns found in the present study are not due to sample idiosyncracies but do represent typical features of the populations under investigation, cross-validations using independent samples are badly needed. Regardless of details of pattern structure, however, the generally positive empirical evidence found for the role of metamemory in the prediction of memory behavior and performance should help to establish the construct in theories of cognitive development.

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Table 1

Mean scores for metamemory, memory behavior, and memory performance measures, separately for third, fifth, and seventh graders (standard deviations in parentheses)

	Grade		
	3	5	7
Task-specific metamemory	3.45 (1.43)	3.90 (1.29)	4.33 (1.33)
General metamemory	5.02 (1.60)	6.90 (1.26)	7.29 (1.28)
ARC clustering (sorting)	0.30 (0.44)	0.51 (0.44)	0.70 (0.36)
ARC clustering (recall)	0.29 (0.42)	0.57 (0.48)	0.72 (0.44)
Reported strategies	2.15 (1.12)	2.97 (1.03)	3.42 (0.78)
Recall estimate 1	9.30 (3.95)	11.94 (3.88)	13.40 (3.49)
Recall estimate 2	10.23 (4.36)	13.54 (4.44)	15.29 (4.20)
Recall	10.97 (3.64)	15.10 (4.54)	18.97 (3.97)

Table 2

Zero-order correlations (lower triangular matrix) and partial correlations[a] (upper triangular matrix) among metamemory, memory behavior, and memory performance measures (collapsed across grades)

	Task-specific metamemory	General metamemory	ARC-clustering (sorting)	ARC-clustering (recall)	Recall
Task-specific metamemory		.11*	.02	.08	.17*
General metamemory	.22*		.20*	.14*	.32*
ARC clustering (sorting)	.10	.26*		.71*	.46*
ARC clustering (recall)	.15*	.23*	.70*		.49*
Recall	.28*	.45*	.50*	.53*	-

[a] Controlling for IQ, self-concept, and attributional style

[b] Correlation coefficients significant at the .05-level are starred

Table 3

Measurement model estimates (factor loadings) for the third-graders

Items \ Construct	Self-concept	IQ	Meta-memory	Memory monitoring	Memory behavior	Memory performance
Self-concept (nonverbal)	0.91					
Self-concept (verbal)	1.00[a]					
Attributional style	0.35					
Classification		1.00				
Matrices		0.40				
Task-specific metamemory			1.00			
General metamemory			0.58			
Recall estimate 1				0.72		
Recall estimate 2				1.00		
Recall estimate 3				0.84		
Reported strategies					1.01	
ARC clustering (recall)					1.00	
ARC clustering (sorting)					0.91	
Recall 1						1.00
Recall 2						0.78

[a] For each construct, one loading was fixed to one to secure that all constructs have the same measurement scale properties

Table 4

Measurement model estimates (factor loadings) for the fifth-graders

Items \ Construct	Self-concept	IQ	Meta-memory	Memory monitoring	Memory behavior	Memory performance
Self-concept (nonverbal)	1.00					
Self-concept (verbal)	0.53	0.38				
Attributional style	0.89					
Classification		1.00				
Matrices		0.69				
Task-specific metamemory			0.54			
General metamemory			1.00			
Recall estimate 1				0.81		
Recall estimate 2				1.00		
Recall estimate 3				0.76	0.40	
Reported strategies					0.77	
ARC clustering (recall)					1.00	
ARC clustering (sorting)					0.86	
Recall 1						1.00
Recall 2						0.71

Table 5

Measurement model estimates (factor loadings) for the seventh-graders

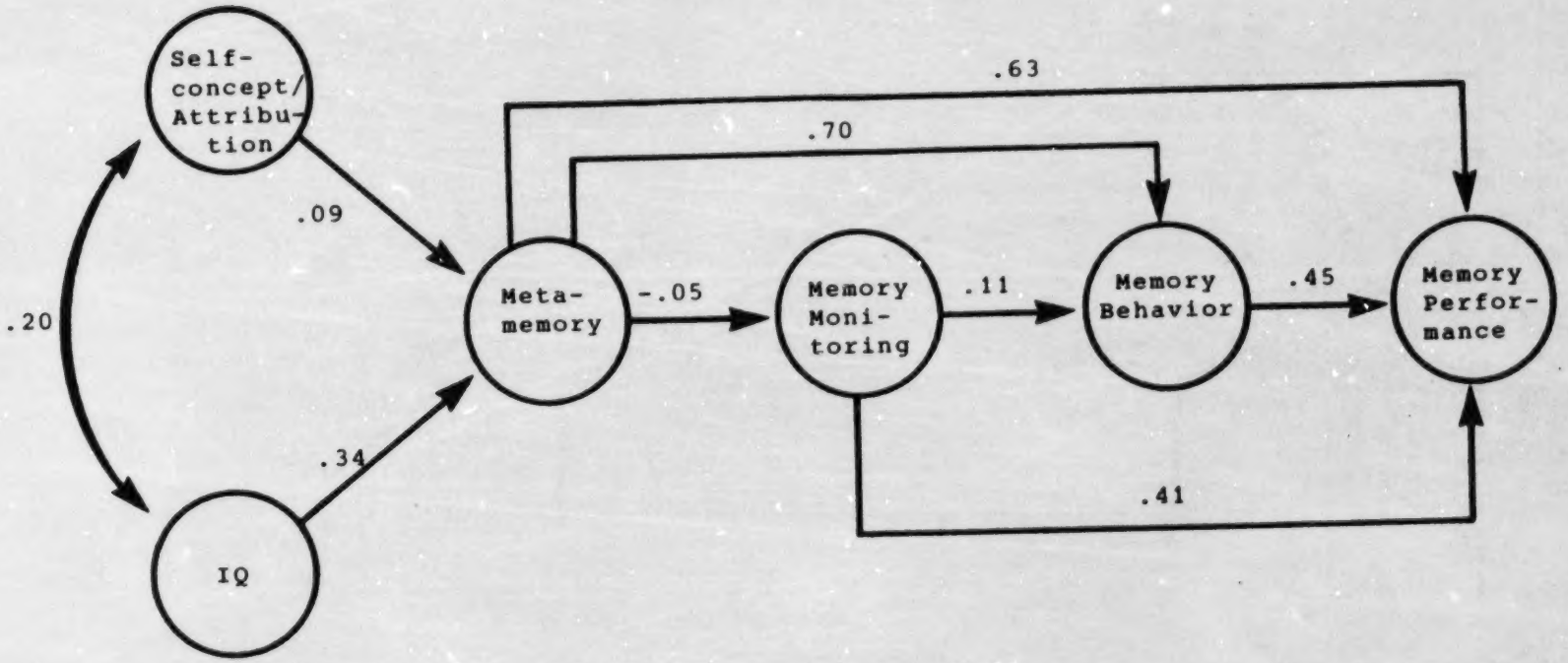
Construct / Items	Self-concept/Attributions	IQ	Metamemory	Memory monitoring	Memory behavior	Memory Performance
Self-concept (nonverbal)	0.32					
Self-concept (verbal)	0.57					
Attributional style	1.00					
Verbal comprehension		1.00				
Classification		0.63				
Task-specific metamemory			0.63			
General metamemory			1.00			
Recall estimate 1				0.71		
Recall estimate 2				0.90		
Recall estimate 3				1.00	0.25	
Reported strategies					0.71	
ARC clustering (recall)					1.00	
ARC clustering (sorting)					0.86	
Recall 1					0.27	1.00
Recall 2						1.16

Figure Captions

Figure 1. Best-fitting LISREL model explaining memory performance in third-graders

Figure 2. Best-fitting LISREL model explaining memory performance in fifth-graders

Figure 3. Best-fitting LISREL model explaining memory performance in seventh-graders


Self-concept/ Attribution
IQ
Meta-memory
Memory Monitoring
Memory Behavior
Memory Performance
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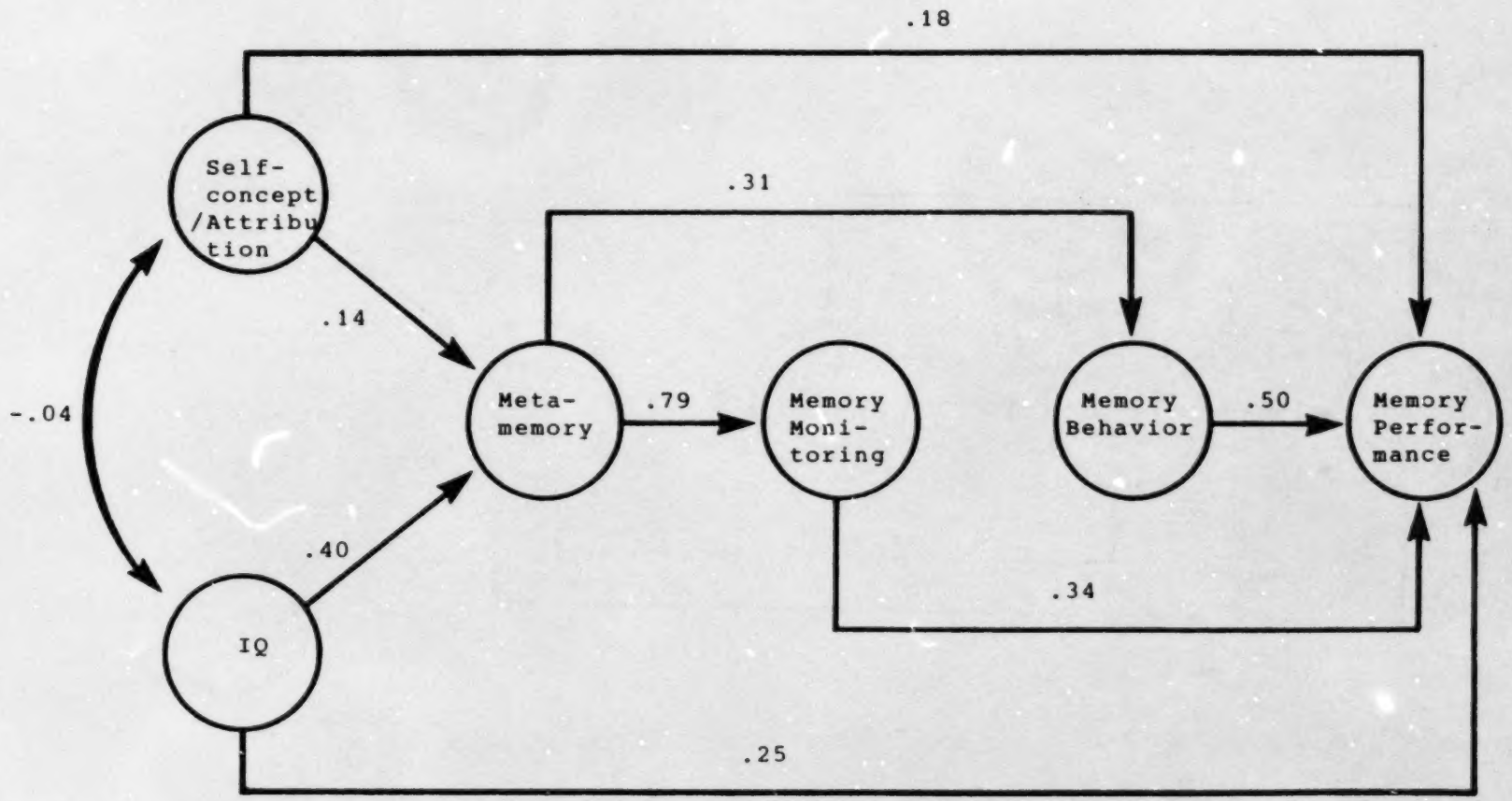
.09
.34
-.05
.11
.45
.63
.70
.41


.18
Self-
concept
/Attribu
tion
.31
.14
-.04
Meta-
memory
.79
Memory
Moni-
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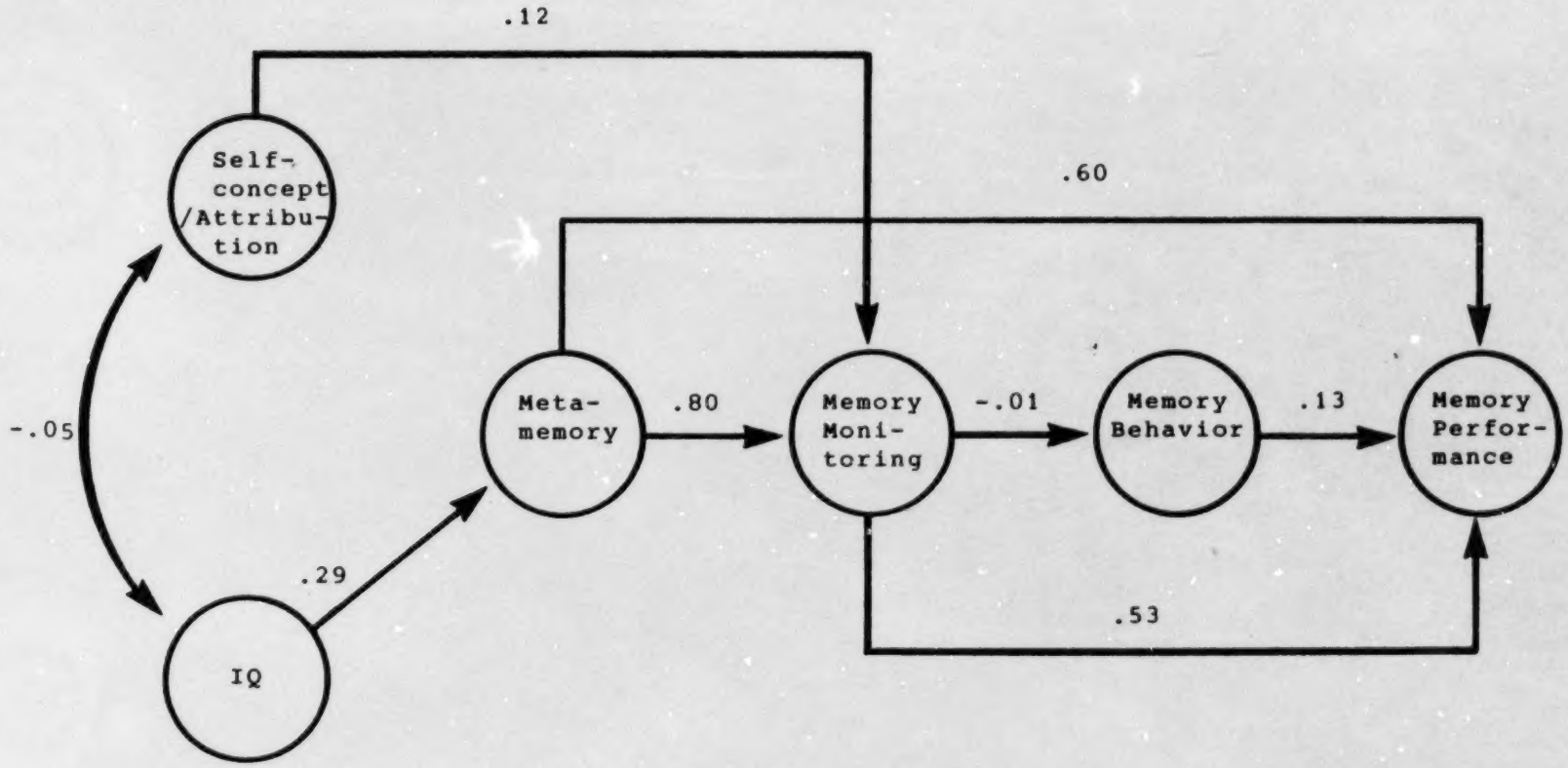
Memory
Behavior
.50
Memory
Perfor-
mance
.40
.34
IQ
.25


.12
Self-concept/Attribution
.60
-.05
Meta-memory
.80
Memory Monitoring
-.01
Memory Behavior
.13
Memory Performance
.29
IQ
.53